[0041] Other variations and advantages are described in the detailed description below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0042] Other objects, features, and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiments and certain modifications thereof when taken together with the accompanying drawings in which:

[0043] FIG. **1** is a high level representation an electronic device **1**, such as a PDA or a cellular phone.

[0044] FIG. **2** illustrates two different embodiments of a typical FSR sensor.

[0045] FIG. **3** is an exemplary plot of the resistance-force relationship for an FSR sensor as illustrated in FIG. **2**.

[0046] FIG. **4** is a plot illustrating the FSR sensor reading (Vout) as a function of the resistance in the FSR material.

[0047] FIG. **5** is a plot illustrating the performance difference between different sample FSR sensors with the same design.

[0048] FIG. **6** is a plot illustrating how the resistance-force relationship changes for the same sensor measured under identical conditions, but at different temperature levels.

[0049] FIG. **7** is a block diagram illustrating the functional flow of the touch screen control software **10** according to the present invention.

[0050] FIG. **8** is a functional block diagram of the Linearization and Homogenization compensation module.

[0051] FIG. **9** is a functional block diagram of the temperature conditioning component of the temperature compensation module.

[0052] FIG. **10** is a functional block diagram of the temperature compensation function of the temperature compensation module.

[0053] FIG. **11** is a plot of the sensor pre-loading force versus voltage output.

[0054] FIG. **12** illustrates how each individual sensor can be mechanically pre-loaded as a part of the sensor structure.

[0055] FIG. **13** is a block diagram of the Auto Calibration & Preloading Compensation of Sensor Data module.

[0056] FIG. **14** represents a touch screen system where the FSR sensor **161** is sandwiched between an activator **164** and a Poron™ backing **165**.

[0057] FIG. **15** shows an exemplary nine-calibration point test map.

[0058] FIG. **16** is an exemplary compensation data table from the nine-calibration point test map of FIG. **15**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0059] The present invention is a software compensation method that allows a touch sensitive display to be built using low-cost force sensors based on force sensing resistive material. The method is suitable for use in electronics devices such as cell phones, PDAs, desktop phones, tablets, copy machines, or any other devices that use differential-pressure touch sensitive displays or panels including LCD, Organic Light-Emitting Diode (OLED) display screens or touch pad/touch lens systems. The present method is herein described in the context of a mechanical differential-pressure touch screen system such as illustrated in FIG. **1** that uses a plurality of force sensors (such as, for example, four) differentially-mounted sensors **7** beneath it all connected to the electronic device **1** processor, as disclosed in International application no PCT/US2007/019606 filed 7 Sep. 2007, which application is herein incorporated by reference in its entirety.

[0060] FIG. **7** is a block diagram illustrating the functional flow of the touch screen control software **10** according to the present invention. The software includes a sensor driver module **12** for interfacing with the sensor hardware. Sensor driver module **12** includes a voltage conversion function that converts the measured voltage levels from the sensors to force levels. Sensor driver module **12** preferably also includes some level of noise filtering, which can be an issue with piezo resistive force sensors since the output voltage is very low. The software also includes a positioning determination module **14** for determining the position of the touch based on the measured forces and the known locations of the sensors. The calculated coordinates are then provided to the overlaying operating system directly or via an API **16**.

[0061] This approach does however not work when using force sensing resistors or other low performing low cost force sensor, such as nano-technology-based sensors. These are not linear, they are temperature dependent, and they perform differently from one sensor to the next. Consequently, the between-sensor error is large, typically +/−15% to +/−30% or even greater. In order to position the FSR based sensors as competitive sensor substitutes to piezo-resistive sensors from a performance perspective, multiple factors must be compensated through software. The compensation algorithms must also be small, not consume RAM or ROM, and be fast, not consume much processing power. In accordance with the present software method the positioning determination module **14** performs one or more of the following functions: 1) Linearization & Homogenization of Sensor Data; 2) Temperature Compensation of Sensor Data; 3) Auto Calibration & Preloading Compensation of Sensor Data; 4) Humidity Compensation of Sensor Data; 5) Voltage Compensation of Sensor Data; 6) Filtering of Sensor Data; and 7) Material Calibration of Touchscreen.

[0062] 1. Linearization & Homogenization of Sensor Data

[0063] As discussed above, the FSR sensors are non-linear in their output values. This means that the output value of sensor (typically in mV) does not vary linearly with the actual force applied (see FIG. **3**). Due to this non-linearity it cannot be expected that correlation of sensors values will reflect the position and value of force applied on the touch screen correctly. A compensation for this non-linearity is needed in order to force the sensors to show the actual force applied. This requires the following function for calculating the absolute force applied on separate sensor (here in mg) using absolute sensor value as an input variable (in mV).

$$Y=A_n*X^n+A_{n-1}*X^{n-1}+\ldots+A_2*X^2+A_1*X^1+A_0$$

[0064] Where:

[0065] X—output value of sensor in mV

[0066] Y—calculated value of force in mg

[0067] n—degree of polynomial function

[0068] An . . . A0—coefficients.

[0069] The accuracy of function calculation depends on the degree used in current polynomial function. The higher the degree, the higher the accuracy in calculation and interpolation, but the lower the performance (requiring more processing power, run time memory, and risk of data overflow during runtime). Thus, the selection of the degree is a balanced design choice. Preferably, the user can set the degree from 2 to 9, and suitable degrees are typically 4 to 6.